It is an object of this invention to provide a modified embryo for the enhanced implantation of the embryo into the endometrium of an animal, or to at least provide the public with a useful choice.

STATEMENTS OF INVENTION

In a first aspect of the invention there is provided a glycolipid-inserted embryo for the preparation of an embryo modified for enhancing the implantation of the embryo into the endometrium of an animal, where:

- the embryo has a glycolipid having lipid tails inserted into a cell membrane of the embryo or into the zona pellucida of the embryo; and
- the glycolipid has been modified to incorporate a binding part wherein said binding part is adapted to enable binding to an attachment molecule.

Preferably, the glycolipid has been modified to incorporate the binding part prior to the insertion of its lipid tails into the cell membranes of the embryo or into the zona pellucida of the embryo.

In a second aspect of the invention there is provided an embryo modified for enhancing the implantation of the embryo into the endometrium of an animal, where:

- the embryo has an attachment molecule which is capable of attaching to the endometrium; and
- the attachment molecule is linked to the embryo by a glycolipid having lipid tails inserted into a cell membrane of the embryo or into the zona pellucida of the embryo; and
- the attachment molecule and the glycolipid have each been modified to incorporate a binding part adapted to enable the attachment molecule and the glycolipid to be bound together via their respective binding parts either directly or through a bridging molecule.

The glycolipid may be any glycolipid capable of inserting its lipid tails into the cell membranes of the embryo or into the zona pellucida of the embryo such as phosphoglycerides or sphingolipids. The glycolipid may be a natural molecule or a modified (e.g. biotinylated) glycolipid. Preferably the modified glycolipid is a biotinylated glycolipid either of the ganglioside class that contains sialic acid groups, or the neutral class that contains galactose.

The attachment molecule may be any molecule that has a binding affinity for molecules on cell membranes (e.g. receptor sites and blood group related antigens) including their mucus coat. Preferably the cell membrane is endometrial. In particular, the attachment molecule is preferably a protein, a peptide (such as poly L-lysine) a carbohydrate, an acyl group, a polymer, or an immunoglobulin such as immunoglobulin G (IgG) or a lectin. Alternatively, the attachment molecule may be a synthetic molecule (e.g. polyvinyl pyrrolidine, or an acyl group) which reacts with molecules expressed on cell membranes or on the mucus layer covering the cell membrane. The attachment molecule can itself be a glycolipid or glycolipid conjugate.

In a third aspect of the invention there is provided a method of preparing the modified embryo of the first aspect of the invention including the step:

- contacting a glycolipid with an embryo, where the glycolipid has been modified to incorporate a binding part, wherein said binding part is adapted to enable binding to an attachment molecule either directly or through a bridging molecule, so that the lipid tails of the glycolipid insert into a cell membrane of the embryo or into the zona pellucida of the embryo.

In a fourth aspect of the invention there is provided a method of preparing the modified embryo of the second aspect of the invention including the steps:

- contacting an attachment molecule with a glycolipid, where the attachment molecule and the glycolipid have each been modified to incorporate a binding part adapted to enable the attachment molecule and the glycolipid to bind together via their respective binding parts either

directly or through a bridging molecule to provide a glycolipid-attachment molecule construct; and then

- contacting the attachment molecule bound to the glycolipid (glycolipid-attachment molecule construct) with an embryo so that the lipid tails of the glycolipid insert into the cell membranes of the embryo or into the zona pellucida of the embryo:

Or including the steps:

- contacting a glycolipid with an embryo, where the glycolipid has been modified to incorporate a binding part adapted to enable binding to an attachment molecule either directly or through a bridging molecule, so that the lipid tails of the glycolipid insert into a cell membrane of the embryo or into the zona pellucida of the embryo; and then
- contacting the glycolipid-inserted-embryo with an attachment molecule, modified to incorporate a binding part wherein said binding part is adapted to enable binding to the binding part of the glycolipid either directly or through a bridging molecule.

Preferably the glycolipid has been modified to incorporate a binding part comprising biotin and the attachment molecule has been modified to incorporate a binding part comprising avidin.

Alternatively, the glycolipid has been modified to incorporate a binding part comprising avidin and the attachment molecule has been modified to incorporate a binding part comprising biotin.

In the case of binding of the glycolipid to the attachment molecule through a bridging molecule, it is preferred that the bridging molecule comprises avidin and that both the glycolipid and the attachment molecule have been modified to incorporate binding parts comprising biotin.

In a fifth aspect of the invention there is provided a method of enhancing the implantation of an embryo into the endometrium of an animal, preferably a human, or domesticated animal, comprising the steps:

- preparing a modified embryo according to the second aspect of this invention, and
- transferring the modified embryo to the uterus of the animal.

In one embodiment of the invention the modified embryo is prepared from a species, hybrid or variety of animal that is the same as the species, hybrid or variety of animal, to the uterus of which it is transferred. In an alternative embodiment, the species, hybrid or variety differ.

In a sixth aspect of the invention there is provided a glycolipid-attachment molecule construct for use in enhancing the implantation of an embryo into the endometrium of an animal comprising a glycolipid modified to incorporate a binding part and an attachment molecule modified to incorporate a binding part wherein the respective binding parts are adapted to enable the modified glycolipid and the modified attachment molecule to bind each other either directly or indirectly through a bridging molecule.

In a seventh aspect of the invention there is provided a method of enhancing the implantation of an embryo into the endometrium of an animal including the steps of:

- introducing a construct of the sixth aspect of the invention into the uterus of the animal so that the construct becomes localised to the endometrium; and then
- transferring the embryo to the uterus of the animal.

In an eighth aspect the invention provides a kit for use in enhancing the implantation of an embryo of an animal comprising one or more preparations of a glycolipid-attachment molecule construct of the sixth aspect of the invention.

While the invention is broadly defined as above, those persons skilled in the art will appreciate that it is not limited thereto and that it also includes embodiments of which the following description provides examples. In addition, the present invention will be better understood from reference to the figures of the accompanying drawings.

CLAIMS

What is claimed:

1. A glycolipid-inserted-embryo for the preparation of an embryo modified to enhance the implantation of the embryo into the endometrium wherein:

- the embryo has a glycolipid having lipid tails inserted into a cell membrane of the embryo or into the zona pellucida of the embryo; and
- the glycolipid has been modified to incorporate a binding part wherein said binding part is adapted to enable binding to an attachment molecule.

2. An embryo as claimed in claim 1 wherein the glycolipid has been modified to incorporate the binding part prior to the insertion of the lipid tails into a cell membrane of the embryo or into the zona pellucida of the embryo.

3. An embryo modified to enhance the implantation of the embryo into the endometrium wherein:

- the embryo has an attachment molecule which is capable of attaching to the endometrium; and
- the attachment molecule is linked to the embryo by a glycolipid having lipid tails inserted into a cell membrane of the embryo or into the zona pellucida of the embryo; and
- the attachment molecule and the glycolipid have each been modified to incorporate a binding part so that the attachment molecule and the glycolipid are bound together via their respective binding parts either directly or through a bridging molecule.

4. An embryo as claimed in any one of claims 1 to 3 wherein the modification to the glycolipid is to the carbohydrate portion of the glycolipid.

32. An embryo as claimed in claim 31 wherein the molecules on cell membranes are receptor sites and/or blood group related antigens.

33. An embryo as claimed in claim 31 or claim 32 wherein the cell membranes are endometrial cell membranes.

34. A method of preparing a glycolipid-inserted-embryo including the step of:

- contacting a glycolipid with an embryo, where the glycolipid has been modified to incorporate a binding part, wherein said binding part is adapted to enable binding to an attachment molecule either directly or through a bridging molecule, so that the lipid tails of the modified glycolipid insert into a cell membrane of the embryo or into the zona pellucida of the embryo.

35. A method of preparing a modified embryo including the steps of:

- contacting an attachment molecule with a glycolipid, wherein the attachment molecule and the glycolipid have each been modified to incorporate a binding part adapted to enable the attachment molecule and the glycolipid to bind together via their respective binding parts either directly or through a bridging molecule; and then
- contacting the attachment molecule bound to the glycolipid with an embryo so that the lipid tails of the glycolipid insert into the cell membranes of the embryo or into the zona pellucida of the embryo.

36. A method of preparing a modified embryo including the steps:

- contacting a glycolipid with an embryo wherein the glycolipid has been modified to incorporate a binding part, wherein said binding part is adapted to enable binding to an attachment molecule either directly or through a bridging molecule, so that the lipid tails of the glycolipid insert into a cell membrane of the embryo or into the zona pellucida of the embryo to provide a glycolipid-inserted-embryo; and then

63. A method as claimed in any one of claims 34 to 62 wherein the attachment molecule is a molecule that has a binding affinity for molecules on cell membranes including the mucus coat of cell membranes.

64. A method as claimed in claim 63 wherein the molecules on cell membranes are receptor sites and/or blood group related antigens.

65. A method as claimed in claim 63 or claim 64 wherein the cell membranes are endometrial.

66. A method of enhancing the implantation of an embryo into the endometrium of an animal including the steps:

- preparing a modified embryo according to the method of any one of claims 35 to 65; and
- transferring the modified embryo to the uterus of the animal.

67. A method as claimed in claim 66 including the step:

- introducing a component with which the attachment molecule will interact into the uterus of the animal so that the component becomes localised to the endometrium.

68. A method as claimed in claim 66 or claim 67 wherein the animal is a human or domesticated animal.

69. A method as claimed in claim 66 or claim 67 wherein the modified embryo is prepared from a species, hybrid or variety of animal different from the species, hybrid or variety of animal of the uterus.

70. A glycolipid-attachment molecule construct for use in enhancing the implantation of an embryo into the endometrium of an animal comprising a glycolipid

modified to incorporate a binding part and an attachment molecule modified to incorporate a binding part wherein the respective binding parts are adapted to enable the modified glycolipid and the modified attachment molecule to bind to each other either directly or indirectly through a bridging molecule.

71. A construct as claimed in any one of claims 70 wherein the modification to the glycolipid is to the carbohydrate portion of the glycolipid.

72. A construct as claimed in claims 70 or 71 wherein the attachment molecule is selected from the group consisting of carbohydrates or oligosaccharides, glycolipids, glycoconjugates, proteins, peptides, acyl groups or polymers.

73. A construct as claimed in any one of claims 70 to 72 wherein the attachment molecule is selected from the group consisting of natural or synthetic carbohydrates or oligosaccharides, proteins or peptides including poly L-lysine, antibodies, lectins, polyvinyl pyrrolidine, and functionally equivalent derivatives thereof.

74. A construct as claimed in any one of claims 70 to 73 wherein the attachment molecule is an immunoglobulin.

75. A construct as claimed in claim 74 wherein the attachment molecule is immunoglobulin G (IgG).

76. A construct as claimed in any one of claims 70 to 75 wherein the attachment molecule is adapted to interact with the epithelial cells of the endometrium, mucus, mucin, or other endogenous or exogenously provided component of mucus.

77. A construct as claimed in any one of claims 70 to 76 wherein the attachment molecule is an endometrial attachment molecule.